## How Does ROSS Work?

Roamer message collection and forwarding is accomplished through a proprietary Message Collection and Forwarding (MCAF) system which monitors, copies and collects selected IS-41 roaming messages only. This process does not alter or affect the operation of IS-41 transmissions.

This system has a message buffering capability which enhances ROSS reliability by buffering messages in memory during an outage. Additional buffering capability can be added. Dial back-up option is available, further increasing the reliability of ROSS.

ROSS takes advantage of existing PCs. By using a terminal emulation software package operating in a Windows™ environment, existing PCs are easily transformed into ROSS terminals. This allows the user to easily move between ROSS and other applications. In addition, a carrier's LAN and WAN can be connected to ROSS to make service available from all of a cellular carrier's locations.
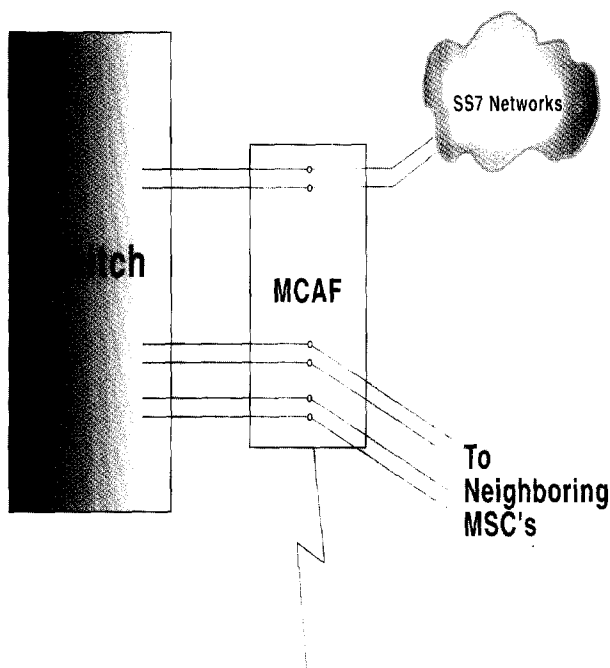
Mobile Switching Center

Switch

MCAF

SS7 Networks

To Neighboring MSCs
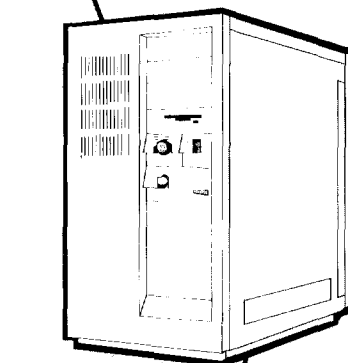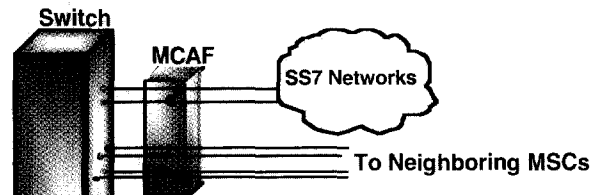
ROSS Service Center
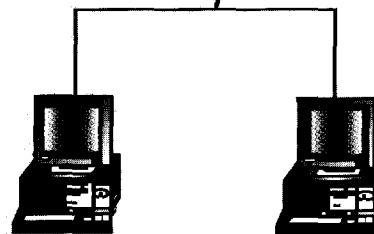
Carrier's Customer Service Center

Roamer On-line Support Service

MCAF Technical Specifications:

The Message Capture and Forward (MCAF) hardware is physically connected to the IS-41 SS7 transmission links (i.e. "A", "B", "F" links) at either the cellular carrier's location or ITN's site. The MCAF device has up to eight ports, supporting a multitude of MSC configurations. The supported physical interfaces to SS7 Links include: DS1, DS0A, and V.35.

Dedicated 56 kbps DDS links are required for MCAF data transmission. The MCAF does not interrupt IS-41 message transmission should a temporary outage occur.

MCAF hardware may be maintained by the cellular operator, while software maintenance is performed solely by the manufacturer.

SS7 Networks

MCAF

To Neighboring MSC's

Would You Like More Information About ROSS? Contact ITN at 913.491.1600 or fax 913.469.0606 to request a live demonstration or additional information on the various ways that **ROSS** can improve your company's customer care program.

*"ITN Links Your Company to the Future in Wireless Communications"*sm

ITN

Seamless Roaming Implementation Guide (SRIG)

BUILDING THE WIRELESS FUTURE ™

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C T I A

Seamless Roaming Implementation Guide
(SRIG)

January 1995

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Foreword

The guiding principal behind the management philosophies of the wireless industry is to always focus on the needs and interest of customers. For the wireless industry to stay ahead in this global marketplace, the wireless network infrastructure must grow and develop and must keep pace with the evolving needs of our customers. To accomplish this we need to know what the customers want. Basically, they want features that are customer-specific rather than location-specific - where they are able to place and receive calls anywhere, at any time, without having to dial special access codes or make special entries to access a particular network. The industry is meeting this challenge of *automatic seamless roaming* by constructing networks that are virtually transparent in the sense that when a customer places a call from a network using any device of choice, that their call will be received by the intended party.

As the wireless industry vision of truly ubiquitous automatic seamless roaming becomes more of a reality each day, our customers' satisfaction improves. Integrating Interim Standard 41 (IS-41) protocol and Signaling System 7 (SS7) with wireline networks has enabled our subscribers to roam not only in wireless networks, but in wireline networks as well. Furthermore, this capability gives the wireless industry capabilities beyond anything ever offered before, such as paving the way to implement a single "personal" number to follow a customer anywhere.

The **Seamless Roaming Implementation Guide (SRIG)** combined with the **Seamless Roaming Implementation Guide (SRIG) Supplemental** provides information on seamless roaming in the form of a cookbook with a set of steps and procedures that are easy to understand and implement. Implementation of new emerging technologies will have a dramatic impact on the SS7 network . It will benefit the wireless carriers by improving operational efficiency, and provide the capabilities to implement new and profitable services. The SRIG identifies these important decision points by streamlining the process by providing the information required for establishing SS7 network connectivity.

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1   Introduction

1.1   Purpose

The vision of automatic seamless roaming has been with us for years, however, the technologies to help the industry achieve this have only recently been developed. The breakthrough was the development of Interim Standard 41 (IS-41). This standard for wireless switches to exchange information about subscribers, provided the following:

> *A standard message set allowing carriers to link switches of different manufacturers.*

> *Provided a high speed method of updating the profile of a subscriber from any location.*

> *A method of automatically allowing calls to be delivered without requiring the subscriber to perform any action.*

For wireless providers this new technology will have several important benefits of increasing revenue per subscriber, operational efficiencies and providing customers a higher level of service.

To insure that the vision of truly ubiquitous automatic seamless roaming becomes a reality the **Seamless Roaming Implementation Guide (SRIG)** and the **Seamless Roaming Implementation Guide (SRIG) Supplemental** have been created as reference manuals for wireless carriers for the deployment of SS7 Network connectivity.

1.2   Scope

This guide has been designed to provide a streamlined process to implement seamless roaming and includes the following:

Selection of a Network Provider - This section is intended to familiarize you with the items to consider when selecting your provider. It will include a list of the available providers and contact information.

Establishing Connectivity - Once a vendor has been selected, installation and testing will be required. While each vendor will have individual differences in their operational procedures, this guide is intended to summarize things to be considered.

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Process to Implement Seamless Roaming - This section includes information needed to assist in the evaluation and prioritization of roaming partner participants and how to modify roaming agreements to incorporate the changes associated with SS7 connectivity.

In addition, a glossary of terms and definitions have been included to assist you in working with service providers, roaming partners, and others within your organization.

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2 Selection of Network Provider

2.1 Objective

Network providers facilitate the implementation of a seamless, wireless telephone network throughout North America. The objective is to implement a seamless infrastructure utilizing Signaling System Number 7 (SS7). SS7 is an ANSI standard that specifies how data messages are packaged and then transported from one point to another. It is a network protocol for high speed digital transmission of data messages. Access to this network is opened to all licensed telecommunication carriers who elect to connect to the network for the transport of IS-41 messages. IS-41 is an industry standard that defines a protocol (language) to enable switches of various types to communicate with each other.

2.2 Benefits of Seamless Roaming Networks

The roaming environment of the past was typified by carrier to carrier communications via clearinghouses. Seamless Roaming Networks now offer carriers the ability to communicate in a direct switch to switch environment using the IS-41 standard. Whether it is pre-call validation or call delivery, IS-41 messaging over SS7 gives carriers more control over their roamer database, use of it at a greater speed, and the potential for reduction in clearinghouse costs.

2.2.1 Improved Fraud Control and reduced costs

The Seamless Roaming Networks will reduce one type of cost associated with fraud: networked pre-call validation will nearly eliminate tumbling fraud costs and reduce the cost of validation services.

2.2.2 Increased revenue through automatic call delivery

The Seamless Roaming Networks will promote the ease of use of call delivery by eliminating the need for cumbersome roamer access codes. The SS7 network supports autonomous registration which allows each carrier to automatically register each roamer as soon as the mobile phone enters the carrier's territory.

2.2.3 Single point access to other cellular networks

Through the gateways established between the network providers, interconnection is provided to the validation and call delivery services of the clearinghouses, as well as to other networks that support IS-41. Through a single connection a carrier gains connectivity to all other carriers including carriers on other networks, plus gains access to clearinghouse services. The carrier needs only a single connection, rather than multiple connections for all the validation and call

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delivery services that are in use today. Such connection involves only one operating agreement and simplifies administration by consolidating all network-related charges onto a single invoice.

2.2.4 No additional charges to reach other Network users

Wireless carriers that are directly connected to certain networks may pay only a single usage charge to reach other carriers that are connected to the network.

2.2.5 Support for X.25 switches

Although the primary switch connection is via the SS7 protocol, it is possible to accommodate those switches that choose to connect using the X.25 protocol. This X.25 protocol conversion service is very reliable and may be a cost-effective alternative to SS7, while fully supporting the functionality of IS-41. This option can save the carrier a significant investment and reduce the cost for validation services compared with SS7.

Seamless Roaming works best when all carriers use IS-41 and can be interconnected to send the appropriate messages throughout the industry without restriction. The SS7 network provides this interconnectivity to make Seamless Roaming a reality. Switches from all vendors that support IS-41 are able to use the SS7 network to provide the industry supported features, including automatic call delivery and pre-call validation.

2.3 Network Providers-Points of Contact

Independent Telecommunications Network (ITN):	Don Wehe	(913) 344-6293
GTE-TSI:	Allen Hemmat	(813) 273-3045
North American Cellular Network (NACN):	John Mulhern	(206) 828-8050

3 Establishing Connectivity with Network Provider

3.1 Getting Connected to a Seamless Roaming Network

The following information is supplemental to the documentation that you should receive from the network provider that you have chosen. You should rely on the information in that document, since it should be more specific than this section can be. The CTIA Backbone Network Customer Handbook (from ITN), Operations Guide (from NACN) and GTE's INLink Customer Handbook are examples of the documentation that you should receive before contracting for SS7 service.

The primary five steps to getting connected to a Seamless Roaming Network include:
Sign an agreement with a Network Provider
Order and Install Equipment at the Mobile Switching Center (MSC)
Exchange Information with the Network Provider
Provision the Interconnection
Test and Accept the Network Connection

3.2 Decision Process

This section assumes that you have made the decisions of what protocol (X.25 or SS7) to use and whether or not you will be provisioning the circuit(s) to the network. Your network provider will explain your choice of either provisioning the circuit(s) or having the network provider take that responsibility.

The table of contents of the CTIA Network Customer Handbook shows the level of detail that you can expect:

General Information
Purpose
ITN's Network Description
SS7 Access to Backbone Network
X.25 Access to Backbone Network
Gateway Screening
Global Title Administration
Routing IS-41 Rev. A SS7 Messages
Point Code Administration
Timer Values (Levels 2 & 3)
SS7 Performance Guidelines
Network Security

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3.3   Order and Install Equipment at the MSC

You should work closely with the manufacturer of your MSC switch to determine what hardware and software upgrades are required to support the IS-41 standard application. This may include increased memory, additional software and new interface cards. The manufacturer should be

able to quote and supply this equipment from off-the-shelf supplies. (Most manufacturers have standard packages to support IS-41.)

You must also order and install at the MSC the specific communications equipment required to interface the MSC with the circuits to the network. This should include a data service unit/channel service unit (DSU/CSU) for each digital, high speed circuit or a modem (for each analog circuit).

The network provider will normally recommend a manufacturer and model that works best with that network, and you should be able to substitute equivalent equipment without significant loss of functionality.

3.4 Exchange Information with the Network Provider

You should be prepared to exchange the required information with the network provider. The network provider needs this information to be able to deliver the level of service that you require. The network provider will respect the confidentiality of the information, and use it only as appropriate.

The information will probably include:
MSC site address
MSC site NPA-NXX
Personnel contacts for Provisioning (names, telephone and FAX numbers, etc.)
Personnel contacts for ongoing Network Control
(names, schedules. 24 hour numbers, beeper numbers, etc.)
Escalation Procedures
MSCID
CLLI Code
Point Code
Switch make and model
Software Generic
Entrance facility limitations

3.5 Provision the Interconnection Circuits

You will have made a number of decisions by the time the circuits are ready to be provisioned. You, in conjunction with the network provider, will have selected the *Meet Point, the Diversity Design, the Testing Responsibility and the Interface Specifications.*

Meet Point is the physical location of the interface between your facilities and the network's facilities. For example, you may choose to provision circuits to the switch location of the

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network provider. The Meet Point is at the network provider's switch site. In this case, you are responsible for all the facilities from your location to the Meet Point.

Another carrier may choose to have the Meet Point at its own switch site. The network provider is responsible for all the facilities from the network to the Meet Point.

The decision regarding the Meet Point is normally made based on comparative costs and desire to maintain operational control of the facilities. Depending on the Network Provider selected each carrier may have options of where the Meet Point will be.

Link Diversity Design is the provisioning design plan that will ensure the isolation of the circuits pairs from the network provider into your switch site. Standards state that no two link segments can use the same physical facilities in order to be considered "diverse." Establishing the most cost-effective design for diversity is a complex effort involving the provisioning personnel of the network provider, the long distance circuit provider(s) and the Local Exchange Carrier(s).

Responsibility for Testing the circuit is normally given to the network provider. The network provider is made aware of the installation progress of all the sections of the circuits and is normally notified when the end-to-end circuit is available for testing.

Interface Specifications are provided to you by the network provider. These specifications will include the speed of each interconnecting circuit and the physical interface (probably V.35, RS-232, DS1, or DS0A).

Once these decisions are made, you should place orders for the facilities with the appropriate landline carriers. The network provider will also place corresponding orders for the facilities from their location to the Meet Point.

For planning purposes, these circuits should be available for test from 30 to 60 business days after they are ordered. The testing should take no more than 10 business days. It may be possible to expedite these processes and to accelerate these timetables (at extra cost to you).

3.6 Test and Accept the Network Connection

There are a standard set of acceptance tests prescribed for SS7 links. These should be executed by the network provider to ensure that all the facilities are ready to be placed in an operations status. Most network providers have automated these tests and will run the tests on their own schedules. If any problems are discovered during the testing, the network provider will correct those problems in the facilities up to the Meet Point. You are responsible for correcting problems in the facilities from your switch to the Meet Point.

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The first test ensures that the physical facilities can support the end-to-end reliability required. These are measuring the quality of the facilities in terms of errors per time period. The cellular switch is not involved in this test, since the test signals are automatically returned (the facilities are placed in a "loopback" mode).

The second and third tests do involve your switch. The second test checks the compatibility of your switch generic software against the software of the network switches. Failures in this test can usually be quickly corrected by changing software (timer) values in your switch.

The third test involves the interaction with at least one of every type of the switch active on the network prior to initial implementation. It ensures that unusual conditions in either the network or your switch will not adversely affect other facilities. Most cellular switch manufacturers have conducted similar tests to certify their software against the standards, so failures at this test level are not common.

This testing should be completed within 10 business days, and will indicate the readiness for live operation. This will also be the "Service Date" for network operation.

Both you and the Network Provider may wish to perform further tests involving other markets on the network, prior to passing traffic to those markets. These are at your discretion and are usually beyond the scope of network testing. Most switches that use generic software loads have passed such switch-to-switch tests. CTIA publishes a Switch Interoperability Matrix describing the interworking of switch pairs. You can request the latest version from CTIA.

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Notes

4 Process to Implement Seamless Roaming

4.1 Starting the Process

To implement seamless roaming, the first step in this process is to determine which markets make business sense for you to enter first. Use Appendix A.1 *"Seamless Roaming Markets List"* sample form which will help you determine which of your roaming partners already participate in seamless roaming. (Since this *"Seamless Roaming Market List"* contains dated material, make sure you obtain from CTIA the **Seamless Roaming Implementation Guide (SRIG) Supplemental** which contains the current *"Seamless Roaming Markets List"*.

Next, make a list of the roaming partners with whom you would like to implement seamless roaming and then evaluate and prioritize each market listed. If there is a high priority market (i.e. neighbor) which is not already participating in seamless roaming, you may want to contact that partner directly to see if they are considering implementation.

4.2 Project Coordination

In the previous section, you should have prioritized your roaming partners to determine with whom (and what switch types) you want to connect via SS7. The following provides a process guide to complete that connectivity.

1. Ensure you have an accurate listing of your company's own NPA-NXX -line ranges.
2. Include with that listing what switch the NPA-NXX resides in, along with the associated point code. (Point Code is critical. Network Providers may assign point codes).
3. Coordinate with your billing system representatives to ensure no issues related to billing calls exist.
4. Prepare an agenda to follow when speaking with each of your roaming partners to ensure all items are discussed. Key points are: (Provided by most Network Providers)
   - Exchange of networking information: switch NPA-NXX -line ranges, point codes
   - Exchange of how and what feature codes will be supported: activation or deactivation for Automatic Call Delivery (ACD), voice mail restrictions (this is critical for customer care assistance)
   - Exchange information on Visitor Location Register (VLR) Timer settings
   - Networking Monitoring Contact Numbers (point of contact if network has problems)
   - Connectivity test call plan (what test calls will be placed to validate connectivity)

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- Vendor notification for Gateway Screening (some vendors may need to turn gateway screening off, per connection)
- Bypass Tables for Clearinghouse Vendor. To Prevent rejections of valid messages and/or to ensure call delivery is handled correctly.

5. Networking Addendum and/or changes to Roamer Agreements
6. Coordinate a meeting or conference call with roaming partner as required.
7. Exchange/discuss above agenda items.
8. Agree to dates and times for switch testing and migration. It is suggested that these dates be provided to your customer care and marketing groups to assist them in troubleshooting any customer problems and/or prior notification to your customers of automatic call delivery and feature portability.
9. Exchange test MIN information.
10. Place test calls, validate connectivity and Automatic Message Accounting (AMA) from switch.
11. If all correct, populate all associated NPA-NXX-line ranges with same point code.

4.3   Roaming Agreements

Carriers execute Roamer Service Agreements in order to provide roamer services to each other's customers. For many years, Roamer Agreements were somewhat comparable due to the similarity of carrier-provided roaming services.

The roaming landscape changed in the early 1990's as roaming fraud became more prevalent. IS-41 and distinct clearinghouse product offerings began to emerge and carriers began deploying different roaming services, such as inter-system hand-off and pre-call validation. Because carriers were deploying different technologies at different times, roamer agreements began taking on different forms. Some carriers were issuing addenda or amendments to their old agreements, others began issuing entirely new agreements to address the changing landscape. Because of the distinct emerging business relationships between carriers, CTIA developed a "Roamer Agreement Options Book" which contained various provisions. To obtain a copy of the Options Book contact CTIA at 202-736-3236. CTIA continues to support the options-based format, and encourages carriers to submit exemplars of roamer agreement provisions so they can be shared with the industry.

4.3.1   Specific Issues to consider for Roamer Agreements

Fraud Liability: There are many levels of fraud detection and identification provided by various companies. A carrier's use or non-use of clone detection, pre-call validation, or even some sort of post-call validation system may be reflected in the type of fraud liability specified.

Inter-system networking: There are several ways in which carriers are networking their systems to provide roamers greater access to features and protection from certain forms of fraud. If carriers are networked through direct switch to switch facilities or access through a network

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provider, the quality and quantity of services afforded to roamers differs. Provisions in the roamer agreement may reflect these types of arrangements.

International roaming: Most carriers have reciprocal roamer agreements with Canadian carriers, some with Mexican carriers, and a few with carriers outside of North America. Because of different currencies, practices, and laws in foreign countries, carriers offering international roaming to their customers will likely require addenda.

The bottom line-- a roamer agreement provision should only be used after careful review by each party to the agreement, and with appropriate modification to suit the needs of the parties.

4.4   Network Coordination: Seamless Roaming NPA-NXX Table Update

There are three major events (initial implementation, add/change/delete Mobile Identification Number (MIN) ranges and change in network element/node) requiring network coordination to ensure that new customers are recognized and provided service wherever they go within Seamless Roaming Networks. This information is incorporated on the *Seamless Roaming NPA-NXX Table Update Form* (Appendix A.2). When any of these events occurs this sample form must be completed by every member switch and protocol converter. The actual updates in each switch are performed by the responsible individual in each market. The updates in the protocol converters are performed by the responsible SS7 provider. To help coordinate and plan these updates use the *Network Coordinated Events Calendar* (Appendix A.3). (Since this sample form contains dated material make sure you obtain from CTIA the **Seamless Roaming Implementation Guide (SRIG) Supplemental** which contains the current *Network Coordinated Events Calendar.* Updating this information is the most common change performed by the Network Providers. Therefore the following general steps are necessary to ensure accuracy and timeliness:

4.4.1   Initial Implementation (Using Seamless Roaming NPA-NXX Table Update)

1. Coordination - 30 days prior to commercial implementation. Items to coordinate include MIN ranges, SS7 point codes, feature codes, CLLI codes, roamer technical data, the IS-41 application test script to be used and test schedule. Information shared at the coordination meeting is used to populate the appropriate switch tables and databases.
2. Market opening-- If the market that you're opening is not on the Seamless Roaming Network, you must request that market to initiate a network opening process. That market should fill out the appropriate forms and send them to their Network Provider. The sample forms are included as Appendix A.4 and A.5.
3. IS-41 Application Testing - 20 days prior to implementation the IS-41 application test script should be run. TIA/EIA document TSB 56-A provides test scripts for automatic roaming and call delivery. If the SS7 connection to the network has not been established it must be completed before this step.

4. Test Review - At least 15 days prior to commercial application the test results for IS-41 application testing should be reviewed. Both markets should agree to the results and resolve any discrepancies.

5. Conversion- Live traffic is transferred to SS7 at the agreed implementation date and time.

4.4.2 Add, Change, Delete MIN Range (Using Seamless Roaming NPA-NXX Table Update)

1. Notification - Roaming partners and Network Providers are notified of the addition, change, or deletion per attachment based on calendar of coordinated events. (Some Network Providers disseminate this information as a service to their member carriers.)

2. Process Change - During the period prior to implementation, additions, changes, and deletions are processed by roaming partners. MIN range additions can be placed in effect after notification. The carrier adding MIN's is responsible for making the numbers effective at implementation. Changes and deletions of MIN's require a coordinated effort to insure switch translations and routing tables are not changed prior to the implementation date.

3. Implementation - MIN's are released to subscribers by home carrier. Coordinated changes are placed in effect by all partners.

4.4.3 Change in Network Element/Node (Using Seamless Roaming NPA-NXX Table Update)

1. Notification - The carrier initiating a change is responsible for notification. All roaming partners and network providers should be given 90 days notice of change. Notification needs to include a detailed description of the activity i.e. "Switch Replacement" etc. At least 60 days prior to implementation points of contacts should be made with all parties. (Some Network Providers disseminate this information as a service to their member carriers.)

2. Testing - During the 30 days prior to implementation, routing verification tests should be scheduled with your network provider and each carrier. Test scripts could address routing only or include all IS-41 functionality dependent on the type of change being made.

3. Implementation - Live traffic is transferred to the changed node at the agreed implementation date.

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5 Glossary and Definitions

5.1 Glossary

ABS	Alternate Billing Service
ACD	Automatic Call Delivery
AGNI	Advisory Group for Network Issues
AIN	Advanced Intelligent Network
AMA	Automatic Message Accounting
ANI	Automatic Number Identification
ANSI	American National Standards Institute, Inc.
ASE	Application Services Elements
ASP	Adjacent Signal Point
AT	Access Tandem
BER	Bit Error Rate
BERT	Bit Error Rate Test
BIB	Backward Indicator Bits
BLERT	Block Error Rate Test
BOC	Bell Operating Company
BPS	Bits Per Second
BSN	Backward Sequence Number
CAMA	Centralized Automatic Message Accounting
CCIS	Common Channel Interoffice Signaling
CCITT	International Telegraph and Telephone Consultative Committee
CCS	Common Channel Signaling
CIC	Circuit Identification Code
CID	Carrier Identification Code
CLASS	Custom Local Area Special Services
CLLI	Common Language Location Identification
COS	Class of Service
CSU	Channel Service Unit
DACS	Digital Access and Cross-Connect System
DLK	Data Link
DPC	Destination Point Code, the SS7 message destination address
DSAC	Dial Service Administration Center
DSCS	Digital Signal Customer Service
DS0	Digital Signal Level 0, 1 Channel, 64 kb/s
DS1	Digital Signal Level 1, 24 Channels, 1.54 mb/s
DS1C	Digital Signal Level 1C, 48 Channels, 3.15 mb/s
DS2	Digital Signal Level 2, 96 Channels, 6.132 mb/s
DS3	Digital Signal Level 3, 672 Channels, 44.736 mb/s